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MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

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MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

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A COMPARISON OF ANCIENT AND MODERN SEQUOIA WOOD

PAUL F. CUNDY

When wood remains buried for extremely long periods of time without losing its fibrous or "woody" character, some very interesting changes take place in its structure and chemical constitution. These changes are shown quite strikingly when the ancient wood is compared with a modern specimen of the same species. In the present instance the comparison has been made between a fossil wood believed to be an ancient form of *Sequoia gigantea* and a specimen of modern Big Tree, *Sequoia gigantea* Decaisne. The fossil wood was unearthed in a bed of Miocene gravel in a mine tunnel in Eldorado County, California, where, it has been estimated, it lay buried thirty million years. The gravel bed, located about a mile from the mouth of the tunnel, is overlaid with eight hundred feet of lava and is part of the bed of an ancient stream. The modern specimen is from Whitaker's Forest in Tulare County, California.

Except for the fact that the ancient wood has a dark brown color and some pieces are twisted and bent, it appears, superficially, to be much like normal wood. In contrast to the modern wood, however, it is quite soft and friable. Most of the pieces may be pulled apart by hand and the fragments thus separated reduced to the size of very coarse sawdust by rolling them firmly between the fingers. Similar characteristics have been noted by other investigators of fossil woods (6).

The structure of the ancient wood resembles very closely that of modern Big Tree wood (pls. 17, 18). The wide band of large thin-walled springwood tracheids makes an abrupt transition to the narrow band of flattened thick-walled summerwood tracheids. The tracheids have bordered pits on the radial walls in one or two rows and smaller bordered pits on the tangential walls in the last few rows of summerwood cells. The pits leading to the ray parenchyma are fairly large, quite uniform in size, and usually oval; there are one to five (generally two) pits per ray crossing. The rays are uniseriate or occasionally in part biseriate, consisting entirely of ray parenchyma cells, and range up to thirty-one cells (800 μ) in height. There are approximately five rays per millimeter tangentially on the transverse section and fifteen to twenty per square millimeter on the tangential surface. The longitudinal parenchyma are metatracheal-diffuse (there seem to be fewer than in the modern wood) and are located chiefly in the summerwood zone. Although normal resin canals are absent, a short tangential row of traumatic (wound) canals is present; these occur occasionally in *Sequoia gigantea.* It is apparent from the

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photomicrographs that many of the cells of the ancient wood have been distorted; in fact, they are almost collapsed in certain areas.

The modern wood was reduced to sawdust, using a power saw with a box for retaining the sawdust; the ancient material was picked apart by hand, with the occasional aid of a knife, and crushed by rolling between the fingers. Both samples were further reduced in a Wiley mill to wood meal passing the forty-mesh sieve. Extractives and ash were determined on the original unextracted wood meal. The extracted wood used for the other determinations was prepared by subjecting a large portion of wood meal to a treatment analogous to that used in the determination of the extractives present in the unextracted wood. This treatment is described later. For the determination of Cross and Bevan cellulose, the fraction of the wood meal which passed the forty-mesh sieve but was retained on the sixty-mesh sieve was used; in all other determinations, the whole wood meal passing the forty-mesh sieve was used.

TABLE 1. CHEMICAL ANALYSIS OF ANCIENT AND MODERN SEQUOIA WOOD. (All calculations are on the basis of ovendry, unextracted wood.)

	Ancient, per cent	Modern, per cent
Ether solubility	0.33	0.74
Alcohol solubility	1.36	12.13
Hot-water solubility	1.71	3.10
Total extractives	3.4	16.0
Ash	1.98	0.77
Lignin	57.1	33.5
Methoxyl of lignin	13.66	13.63
Pentosans	4.0	12.3
Uronic anhydride ($CO_2 \times 4$)	1.72	4.68
Cross and Bevan cellulose	38.2	37.3
Alpha-cellulose (determined on Cross and Bevan cellulose)	26.4	29.1
Viscosity of Cross and Bevan cellulose	6.2 cp.	23.6 cp.

The ether and alcohol solubilities were determined by extracting the wood meal, successively, eight hours with ether and sixteen hours with 95 per cent ethyl alcohol in a Soxhlet extractor. The hot water solubility was determined by heating water suspensions of this extracted wood meal in a hot water bath for three one-hour periods. The lignin, methoxyl of the isolated lignin, and the alpha-cellulose and viscosity of the Cross and Bevan cellulose were determined by TAPPI standard methods (7). Cross and Bevan cellulose was determined by a modification of the Forest Products Laboratory procedure (2), the principal difference being that the wood meal, after being chlorinated, was heated four minutes instead of thirty minutes with 2 per cent sodium sulfite solution. Pentosans were determined by distillation with 12 per cent hydrochloric acid followed by precipitation with phloroglucinol (1). Uronic anhydrides were determined by a modification of the method of Burkhart, *et al.* (3); the principal change involved heating the hydrochloric acid suspension of the wood fifteen minutes at a temperature of 70° centigrade to remove carbonate CO_2 before the absorption tube was attached.

In contrast to the experience of other investigators (4, 5, 6) no difficulty with gelatinization was encountered in the preparation of Cross and Bevan cellulose from the ancient wood. The delignification proceeded much more rapidly than did that of the modern specimen. The results of the analyses are shown in Table 1.

If the composition of the woods is compared on the whole wood basis, it will be noted that there have been marked decreases in extractives, pentosans, and uronic anhydride in the ancient wood, and a large increase in lignin. Cross and Bevan cellulose appears to be practically unchanged.

The greatest differences in composition are in lignin, which apparently increased, and extractives (particularly alcohol extractives), which decreased. The increase in lignin content is particularly intriguing. It is conceivable that extractives might, upon aging, become insoluble in 72 per cent sulfuric acid, as well as in the usual solvents, and be isolated with the lignin, thereby accounting for some of the increase in the latter. However, the remarkable similarity of the methoxyl content of the lignin isolated from the two woods makes this assumption untenable because the methoxyl content of the extractives is much lower than that of lignin. Since the alcohol-soluble portion would be partially water-soluble as well, it is more likely that most of the extractives have been lost. Therefore, to explain the increased lignin content, it must be assumed that lignin is more resistant to deterioration than are any of the other major constituents of wood and thus appears to increase in quantity because the other constituents are lost so much more rapidly, a suggestion which has been made by other investigators.

If the further assumption is made that none of the lignin has been lost, the basis is provided for a more rational comparison of the two woods. In other words, if it is assumed that instead of 57.1 per cent, the lignin content of the ancient wood was originally the same as that shown by the modern wood (33.5 per cent) and no lignin was lost, 58.7 per cent [(33.5/57.1) × 100] of the original wood remains and the other analyses should be adjusted accordingly. Although it is impossible to say how nearly correct this assumption may be, it furnishes the only logical basis of comparison. Jahn and Harlow (5) found that, in ancient beechwood, the loss in weight as calculated from the increase in lignin, assuming no loss of lignin, agreed almost exactly with the loss in weight as calculated from apparent density measurements. This would

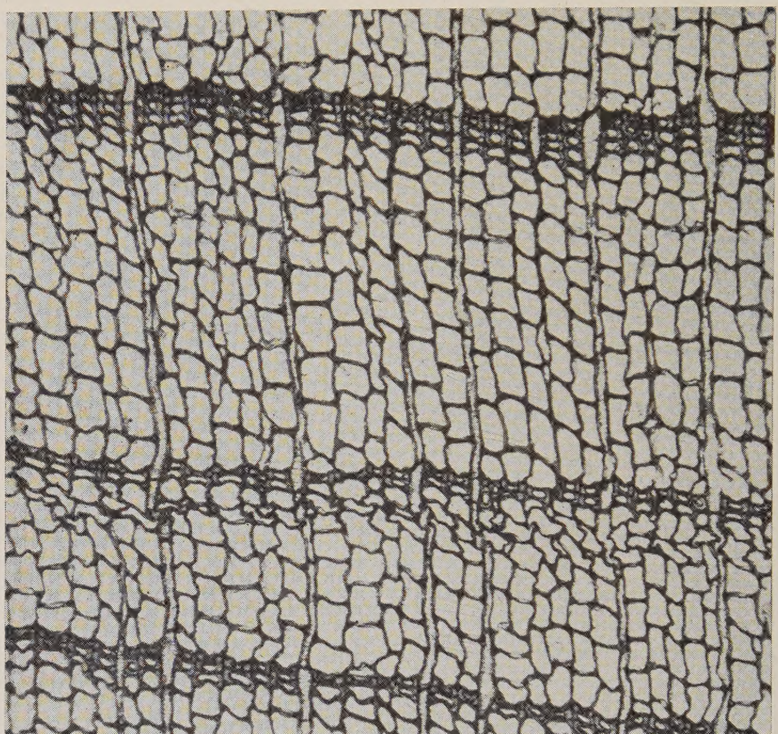

Plate 17. Structure of Ancient Wood, × 100.

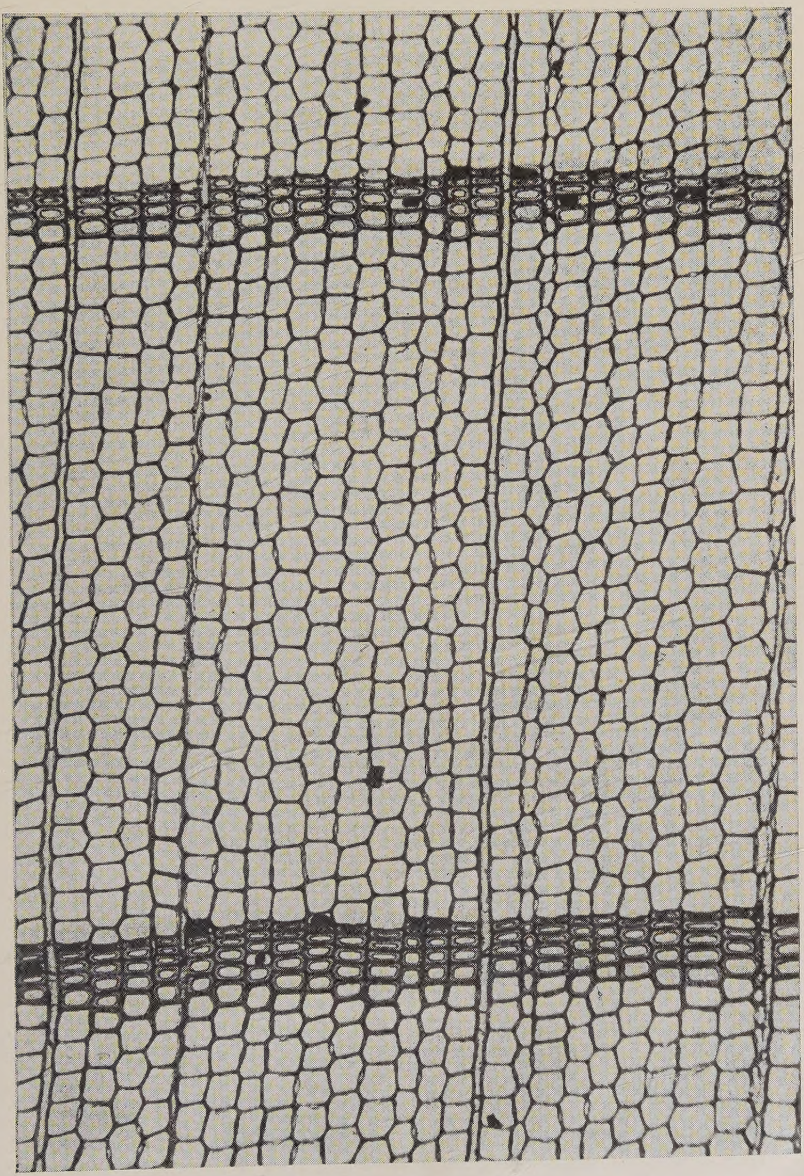

Plate 18. Structure of Sequoia gigantea, × 100.

indicate that, in this case, there had been neither a loss nor an accumulation of lignin. In an attempt to provide such an independent check in the case of the sequoia wood, density measurements were made on both samples. Small rectangular blocks of the woods, dried to constant weight, were dipped in hot paraffin, and then weighed in and out of water, weighting the wood sufficiently to overcome its tendency to float. The weight of water absorbed by the wood during the period of immersion necessary to complete a weighing was negligible.

On the ash-free basis, the apparent densities of the ancient and modern samples are, respectively, 0.222 and 0.323. These results were confirmed by calculations made from actual measurement of the dimensions of the blocks. Using these density values, it would appear that 68.7 per cent of the original wood remains, as compared with 58.7 per cent as calculated from the gain in lignin. From this, it might be concluded that some lignin has accumulated in the aging process but, as previously mentioned, the methoxyl content of the two lignins lends little credence to this view. At least part of the discrepancy might be explained by assuming that the pressure of the lava and other overburden has had a compressing effect on the ancient wood, thereby increasing its apparent density. An examination of the cell structure of this wood (plate 17) shows cell deformation amounting, in some cases, almost to collapse. Such a change would, of course, increase the apparent density of the wood and lead to a fictitiously low value for the loss in weight as calculated from the decrease in apparent density.

TABLE 2. ADJUSTED CHEMICAL ANALYSIS OF ANCIENT WOOD

	Basis—Wood of normal lignin content, per cent	Loss—Basis, normal wood, per cent
Extractives	2.00	87.5
Ash	1.16	33.6*
Cross and Bevan cellulose	22.4	39.9
Alpha-cellulose	15.5	46.7
Pentosans	2.3	81.3
Uronic anhydride ($CO_2 \times 4$)	1.01	78.4

* Gain.

Thus, although density measurements do not confirm the assumption that lignin is neither lost nor accumulated, neither do they interpose any serious objections to its use as a basis for calculation. It need hardly be pointed out, of course, that the one basic assumption upon which all these comparisons are made can never be affirmed—namely, that the modern wood has the same chemical and physical constitution as did its ancient prototype in its original state.

In the first column of Table 2 is shown the composition of the ancient wood adjusted to conform to the assumption that no lignin has been lost and, accordingly, that 58.7 per cent of the original wood remains. The second column shows the percentage difference from the composition of modern big tree wood.

When this basis of comparison is used, it appears that only about 12 per cent of the original extractives and 20 per cent of the pentosans and uronic anhydrides of the ancient wood remain, as compared with a retention of about 55–60 per cent of the cellulose. The loss of so-called hemicelluloses is, in other words, approximately twice as great as that of cellulose, a point which is not too surprising because they represent, principally, molecules of a lower degree of polymerization than cellulose. There is some evidence, however, that the cellulose suffered greater deterioration during burial than is indicated by the percentage loss shown in Table 2. Alpha-cellulose and viscosity measurements made on Cross and Bevan cellulose from the ancient wood showed losses of 12.7 and 73.3 per cent, respectively, from the values of corresponding measurements made on Cross and Bevan cellulose from the modern wood, despite the fact that a greater number of chlorinations were required to delignify the modern wood. This suggests that what cellulose remains in the ancient wood possesses a considerably lower degree of polymerization than it did originally. The increase in ash content, which is found in all woods which have been buried for long periods of time, is to be expected. No evidence of petrification was found.

Grateful acknowledgment is made to Professor Emanuel Fritz, of the Department of Forestry at the University of California, who obtained the samples of the two woods and to the Pacific Lumber Company who made them available to this laboratory. Especial thanks are due Dr. I. H. Isenberg who prepared the sections of the wood, examined them microscopically, and provided the portion of the description which relates to that examination, and to Dr. B. L. Browning who made valuable suggestions regarding the analytical work. Thanks are also due Miss Eda Nihlen for preparing the photomicrographs and Miss Virginia West for making the viscosity measurements.

The Institute of Paper Chemistry,
Appleton, Wisconsin.

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NOTES ON TRIFOLIUM ERIOCEPHALUM NUTTALL

James S. Martin

During a recent taxonomic study of the native clovers of the United States, several nomenclatural ambiguities were discovered. Two varieties of *Trifolium eriocephalum* Nuttall long have been known under invalid names and the distinctions between the several varieties never have been very clear-cut. The species and its four varieties are revised here in an attempt to correct these difficulties. Herbarium material from the following institutions has been studied: University of California, Berkeley, California; Dudley Herbarium, Stanford University, California; Gray Herbarium, Harvard University, Cambridge, Massachusetts; New York Botanical Garden, New York, New York; Pomona College, Claremont, California; Philadelphia Academy of Sciences, Philadelphia, Pennsylvania; Utah State Agricultural College, Logan, Utah; University of Washington, Seattle, Washington. I am deeply grateful to the curators of these herbaria for the loan of their material.

Trifolium eriocephalum Nutt. in Torrey and Gray, Fl. N. Am. 1: 313. 1838.

Usually villous or rarely glabrous perennials; stems branching from apex of thick, deep root, erect or spreading, 5–45 cm. tall, 1–3 mm. in diameter; leaflets always 3, varying in shape; inflorescence 25–85-flowered, 15–30 mm. in diameter, without an involucre, the pedicels less than 0.8 mm. long, the entire inflorescence often horizontal or sometimes inverted because of the bending of the peduncle just beneath the head; flowers yellowish, pink, purplish or ochroleucus, 8–16 mm. long, sharply reflexed, the curvature sharp near the base; calyx somewhat shorter than the banner, the tube 1–3 mm. long, membranous, strongly 10(9–11)-veined, teeth slenderly subulate, sharp but not spine-tipped, often curved and twisted, usually villous with long diverging hairs 0.7–2.5 mm. long, the lower teeth 2–5 times as long as the tube, the upper teeth subequal to or shorter than the lower; banner ovate, oblong, or elliptical, the apex rounded (rarely acute), apiculate or slightly retuse, adnate to the claws of the wings for 0.7–2 mm. at the base; wings from equal to 2 mm. shorter than the banner, the blades usually much shorter than the claws, blunt or shortly acute; keel equal to 1 mm. shorter than the wings, the blades much shorter than the claws, boat-shaped, sometimes slightly rostrate; legume sessile, small, densely villous especially towards the apex (rarely glabrous), membranous, often nearly veinless, 2–7-ovuled, 1–4-seeded; seeds smooth, 1.5–3 mm. long.

Key to Varieties

Ovaries mostly with more than two ovules (usually 4-ovuled).
  Leaflets of at least the basal leaves broad and rounded, rarely retuse; upper leaves with elliptical or oblong, rounded or acute leaflets, but never linear and acuminate.
    Basal leaves glabrous; northeastern Oregon and adjacent Washington and Idaho .... b. *T. eriocephalum* var. *Piperi*
    All leaves noticeably villous; Utah .... d. *T. eriocephalum* var. *villiferum*
  All leaflets narrow, linear, acuminate, rarely acute .... c. *T. eriocephalum* var. *Cusickii*
Ovaries 2-ovuled, rarely a few ovaries with 3 ovules .... a. *T. eriocephalum* var. *typicum*

a. T. ERIOCEPHALUM Nutt. var. **typicum** nom. nov. *T. eriocephalum* Nutt. in Torrey and Gray, Fl. N. Amer. 1: 313. 1838. *T. scorpioides* Blasdale, Erythea 4: 187. 1896; type, along Mad River, Humboldt County, California, June 8, 1896, *W. C. Blasdale* (Herb. Univ. Calif.). *T. arcuatum* Piper, Bull. Torrey Bot. Club 28: 39. 1901, as to type only, other specimens cited and other material identified as such by Piper belong in the variety *Piperi;* type, Simcoe Mountains, Klickitat County, Washington, June 6, 1884, *W. N. Suksdorf 270* (Gray Herb.). *T. eriocephalum* Nutt. f. *arcuatum* (Piper) McDermott, N. Am. Species Trifolium 231. 1910, as to name only, not material cited. *T. eriocephalum* Nutt. var. *arcuatum* (Piper) McDerm. *apud* Peck, Man. Higher Plants of Oregon 429. 1941. *T. eriocephalum* Nutt. var. *Butleri* Jepson, Fl. Calif. 2: 302. 1936; type, Log Lake, Shackleford Creek, Siskiyou County, California, August 3, 1908, *G. D. Butler 384* (isotype, Herb. Univ. Calif.).

Leaflets mostly elliptical or oblong, acute to narrowly rounded and often apiculate at the apex, 4–12 mm. wide, 20–50 mm. long, densely villous on both sides, rarely glabrous; calyx one-half to three-fourths as long as the banner; legume densely villous towards the apex, rarely nearly glabrous, 2-ovuled, rarely a few ovaries with 3 ovules, 1(2)-seeded. Flowering from early May to July.

Type. Prairies of the Wahlamet [Willamette], Oregon, *T. Nuttall* (Herb. N. Y. Bot. Gard.).

Distribution. From Klickitat County, Washington, to Mendocino County, California; foothills and lower mountain slopes, 2000 to 7000 feet elevation.

Representative material. *W. C. Cusick 2811a; H. M. Hall 4076; A. A. Heller 10047, 13636; L. F. Henderson 36, 196, 3095, 12330, 12341; J. W. Thompson 710, 4284, 4377, 4675, 10195, 13081; J. P. Tracy 2641, 2759, 5834, 7729, 8728, 8769, 8770, 8821, 8835.*

A discussion of *T. arcuatum* is given under var. *Piperi.* The variety *Butleri* of Jepson includes some of the smaller specimens of the typical variety occurring in northern California. A part of the type collection and Jepson's other cited specimen (*Chandler 1712*) are reduced in size but otherwise not different. In Humboldt County, California, a few plants have been collected which are nearly glabrous but do not otherwise differ from other specimens in the same region. All gradations from nearly glabrous to densely villous are found and consequently no recognition is given these plants.

b. T. ERIOCEPHALUM Nutt. var. **Piperi** var. nov. *T. arcuatum* Piper, Bull. Torrey Bot. Club 28: 39. 1901, as to material cited except for the type.

Caules villosi vel glabrati, 5–30 cm. longi, 1–3 mm. lati. Foliolae foliorum superiorum ovatae vel ellipticae vel oblongae, apicibus rotundis vel acutis, glabratae vel aliquantae villosae, 4–13 mm. latae, 20–40 mm. longae; foliolae foliorum inferiorum latae et breves, saepe obovatae et retusae, integerrimae; stipulae superiores 15–30 mm. longae, lanceolatae vel ovatae. Flores 12–15 mm. longi, petalis flavis vel puniceis pallidis vel albis (?); calycibus $\frac{2}{3}$–$\frac{3}{4}$ longitudinum vexillorum, fistulis calycum 1.5–2.7 mm. longis; dentibus inferioribus 5–8.5 mm. longis, 3–4 longitudinum fistularum, subglabratis vel aliquantis villosis. Legumina ad apicis villosa aliquanta 4–5(3–7)-ovulatis, 1–3-seminibus.

Leaflets of the upper leaves ovate, elliptical or oblong, rounded or acute at the apices, glabrous or moderately villous, 4–13 mm. wide, 20–40 mm. long; leaflets of the basal leaves broader and shorter, often obovate and retuse, entire; calyx two-thirds to three-fourths as long as the banner; legume moderately villous at the apex, 4–5(3–7)-ovuled, 1–3-seeded. Flowering in June and July.

Type. Paradise, Wallowa County, Oregon, June 12, 1900, *W. C. Cusick 2405* (Gray Herbarium; isotypes, Herb. Univ. Calif., N. Y. Bot. Gard., Pomona College, Univ. Wash.).

Distribution. Northeastern Oregon and adjacent Washington and Idaho; moist mountain meadows and woods, 3500 to 6500 feet elevation.

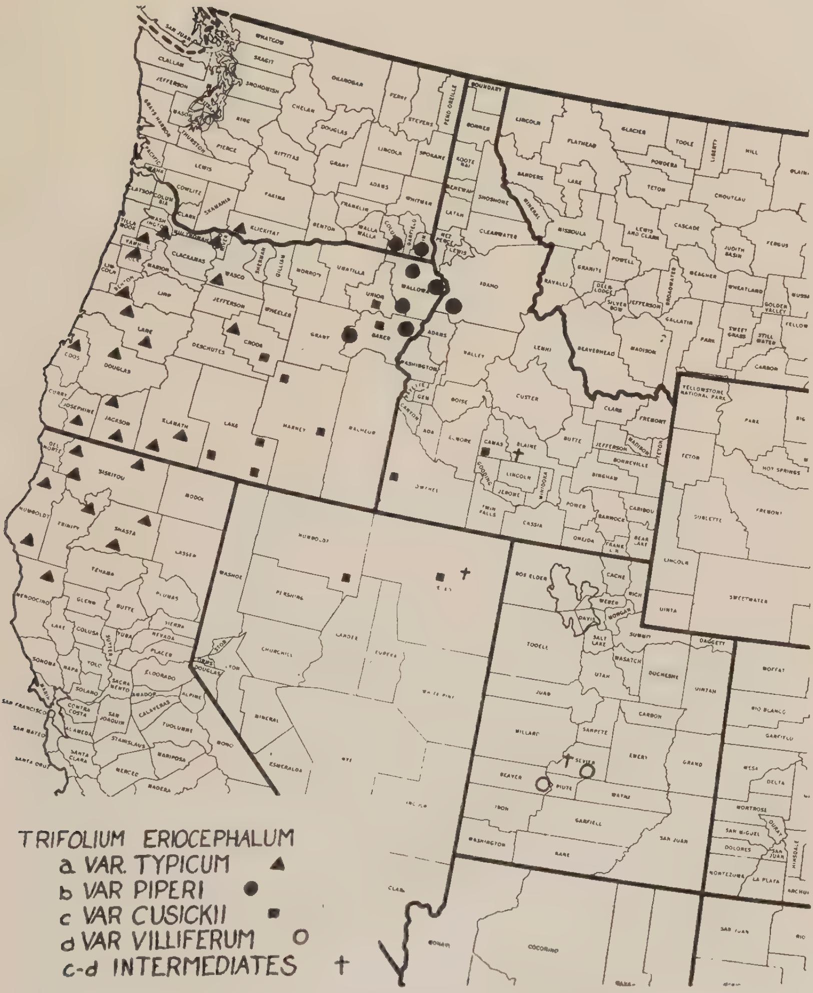

FIG. 1. Distribution of *Trifolium eriocephalum.*

Representative material. *W. C. Cusick 943, 2432, 2797, 3258d; R. Ferris 1158; L. F. Henderson 5386; G. N. Jones 1877; M. E. Peck 17544, 17993.*

This variety is distinguished easily from the typical variety by the more numerous ovules. Two-ovuled pods are found occasionally but the majority of the ovaries on any plant have more than two. A very few plants are intermediate in this respect, having a rather large number of 2-ovuled pods (*Cusick 2797; Peck 17993*). From var. *villiferum,* var. *Piperi* is distinguished less clearly. The var. *Piperi* has broad, glabrous basal leaflets while var. *villiferum* has narrower leaflets all of which are villous. Since var. *Cusickii* has the leaflets all narrow with slender apices, it is distinguishable from var. *Piperi* although in some cases the upper leaflets of the two varieties may be rather similar.

The plants included here have long been known as *T. arcuatum* Piper or as f. *arcuatum*. In his original description Piper cited a type and four other specimens. I have examined three of these and they are var. *Piperi*, but Piper's type specimen is a two-ovuled plant belonging with the typical variety. It is therefore necessary to redescribe the entity as a new variety.

c. T. ERIOCEPHALUM Nutt. var. **Cusickii** (Piper) comb. nov. *T. arcuatum* Piper var. *Cusickii* Piper, Bull. Torrey Bot. Club 29: 641. 1902. *T. harneyense* Howell, Fl. N. W. Am. 1: 134. 1897; type, Harney Valley, Oregon, 1887, *T. Howell*. *T. arcuatum* Piper var. *harneyense* (Howell) McDerm. N. Am. Species Trifolium 231. 1910. *T. tropicum* Nelson, Bot. Gaz. 54: 409. 1912; type, Jordan Valley, Owyhee County, Idaho, June 22, 1911, *J. F. Macbride 967* (isotypes, Gray Herb.).

Leaflets all linear or very narrowly lanceolate, 2–6 mm. wide, 30–75 mm. long, with slender acuminate apices, glabrous or more often villous, especially along the midveins, often folded and falcate; calyx one-third to one-half as long as the banner; legume sparingly to densely villous towards the apex, 4–5-ovuled, 1–3-seeded. Flowering in June and July.

Type. Camp Creek, Maureys Mountains, Oregon, July 2, 1901, *W. C. Cusick 2628* (istoypes, Univ. Calif., Gray Herb.).

Distribution. Eastern Oregon, northeastern Nevada, and adjacent Idaho; in moist meadows and open woodland, 4000 to 7000 (?) feet elevation.

Representative material. *E. I. Applegate 7724, 7754; C. C. Bruce 2290; L. Constance (Henderson 9646); W. C. Cusick 1659a, 2049, 2075a; A. A. Heller 9032; M. E. Peck 2327, 10375, 13895; J. W. Thompson 12058.*

McDermott called this entity f. *harneyense*, basing her usage on Piper's reduction of *harneyense* to a variety under *arcuatum*. She gives the date for this change as 1901 but does not cite the publication by name. I suspect that the combination actually never had been made and therefore *Cusickii* is the earliest valid varietal name.

d. T. ERIOCEPHALUM Nutt. var. **villiferum** (House) comb. nov. *T. villiferum* House, Bot. Gaz. 41: 335. 1906. *T. eriocephalum* Nutt. f. *villiferum* (House) McDerm. N. Am. Species Trifolium 242. 1910.

Leaflets elliptical or oblong, rounded, more rarely acute, 7–13 mm. wide, 30–50 mm. long, all leaflets moderately to densely villous on both sides; calyx one-half or less the length of the banner; legume villous, 4-ovuled, 1–2-seeded. Flowering in June and July.

Type. Beaver City, Beaver County, Utah, 1877, *E. Palmer 91* (isotype, N. Y. Bot. Gard.).

Distribution. South central Utah, 6000 to 7000 (?) feet elevation.

Representative material. Deep Creek, June 6, 1891, *M. E. Jones;* Ibapah, June 22, 1891, *M. E. Jones.*

A number of collections show characters intermediate between the varieties *Piperi* and *Cusickii,* from which this variety is distinguished mainly by the possession of broad, always villous leaflets. The range of the available specimens is so far removed from those of the other varieties that I recognize the variety with less basis than usual. In some ways var. *villiferum* is intermediate between var. *Cusickii* and var. *Piperi.*

Eastern New Mexico College,
Portales, New Mexico.

PINUS: THE FERTILE SPECIES HYBRID BETWEEN KNOBCONE AND MONTEREY PINES

Palmer Stockwell and F. I. Righter

Fresh pollen collected from Monterey pine (*Pinus radiata* Don) growing a few feet above sea level near Monterey, California, was applied in April, 1927, to receptive conelets of the Sierra foothill form of knobcone pine (*Pinus attenuata* Lemmon) growing at an altitude of 3000 feet near Placerville, California, by Messrs. J. S. Barnes and W. C. Cumming of the Institute of Forest Genetics (then known as the Eddy Tree Breeding Station). The hand-pollinated cones were harvested in the autumn of 1928, and the hybrid seeds from these cones were sown in a seedbed the following spring. Twenty-eight two-year-old seedlings from this cross were planted in a block at 15 by 15-foot intervals in the Eddy Arboretum. Adjacent to them were planted a few seedlings of the two parent species.

In February, 1932, a cold wave swept the Sierra foothills. Minimum air temperatures at 16.4° F. at four feet above the ground and 15.4° F. at ground level were recorded at the Institute weather station. Seedlings of the knobcone pine were not injured by this temperature; some foliage of the hybrids was lightly frosted; and all the Monterey pine seedlings were either killed or permanently deformed. Absence of permanent injury to the hybrids, at a temperature that was ruinous to one of the parent species, stimulated interest in their subsequent behavior. Later, in January, 1937, when the trees withstood a temperature of 11.8° F., their resistance to cold was further emphasized.

When the hybrid trees were 16 years old, in April, 1945, they presented a relatively uniform appearance, although measurements revealed considerable difference in size between trees. The tallest tree was 61.7 feet, the shortest 42.0 feet, and the average was 52.3 feet. The tree of greatest girth was 19.3 inches in diameter at breast height, the smallest was 9.5 inches, and the average was 12.8 inches. Adjacent knobcone pines of the same age averaged 39.6 feet in height and 10.1 inches in diameter. Adjacent Monterey pines planted at the same time had been killed or so badly damaged by frost that measurements were meaningless; however, other Monterey pines that escaped the freeze in another part of the arboretum have shown a somewhat greater growth rate than that of the hybrid trees.

The F_1 hybrid is more limby than Monterey pine but otherwise similar in general appearance. Because of its numerous, heavy branches, it is not recommended as a timber tree; it may prove to be a desirable ornamental tree, however, in localities that are slightly too cold for Monterey pine.

Some of the hybrid trees produced cones and catkins when they were four years old, and ten years all were bearing a dozen or more cones per tree annually. In 1940 seed from open-pollinated cones (mutual wind pollination between F_1 hybrids) and seed of knobcone pine were planted in a seedbed. After five years the seedlings were compared. While there was much variation in individual growth rate, in general the F_2 hybrids grew faster than knobcone pine seedlings. Although the F_1 hybrid grew more slowly than Monterey pine, the growth rate of some individuals of the F_2 population compares favorably with that of the best Monterey seedlings.

Because many of the F_2 hybrids had not yet borne cones, the preliminary survey was limited to the distribution of needle characters. Of 73 seedlings examined, 76.6 per cent had fine or medium slender needles resembling those of Monterey pine, while 23.4 per cent had coarser needles much like those of knobcone pine. The needles of 21.9 per cent of the trees had the chalky-white stomata characteristic of knobcone pine, 28.7 per cent had translucent stomata similar to those of Monterey pine, and 49.4 per cent had stomata that were intermediate in character.

The character segregation (Table 1) is based on small numbers of specimens, and must be regarded with suspicion because possible disturbing factors are not yet known. However, the fertility of the F_1 hybrid seed, the small percentage of abortive pollen, and the general segregation of other characters all suggest that the parents of this hybrid are closely related forms, at most ecospecies of the Turesson relationship concept, rather than distinct or remote species of the Linnaean concept. The natural crossing of these entities where their ranges impinge adds corroborative evidence to this concept of their relationship. Monte-

TABLE 1

Morphological characters that distinguish *Pinus attenuata* × *P. radiata* F_1 and F_2 from the parent species

Characters	*Pinus attenuata*	*Pinus radiata*	F_1 hybrid (*P. attenu-radiata*)	F_2 hybrid
Tree form	low, spreading, or erect	tall, excurrent	tall, excurrent	excurrent
Branching	profuse, ramified, irregular	less profuse, whorled	intermediate	segregation not known
Growth rate	moderate	rapid	rapid	rapid
Frost resistance	uninjured at 16° F.	killed or deformed at 16° F.	uninjured at 16° F.	not known
Bark	gray-green, late forming, trunk smooth	dark gray, early forming, trunk rough	intermediate	not known
Foliage color	gray-green	dark clear green	dark clear green	mostly dark green
Needle arrangement	in threes, sparse	in threes, abundant	in threes, abundant	in threes
Needle thickness	relatively coarse	slender, flexible	relatively slender or intermediate	23.4% coarse 76.6% fine or intermediate
Resin canals	usually two, sometimes more	two	two	two, occasionally absent
Stomata, color	glaucous, chalky white	translucent, not glaucous	all more or less chalky	21.9% chalky, others translucent or intermediate
Stomata, shape	sunken, margins flat	conic, margins raised	segregating, mostly intermediate	segregation approximately 37% sunken; 63% conic or intermediate
Cones, position	many on trunk, often embedded in the wood	few on trunk, seldom embedded	intermediate	not known
Cone scale, apophysis	yellow, carinate, narrowly tuberculate	brown, tumescent-tuberculate	brown, shape intermediate and variable	not known
Cone scale, spine	prominent, spine introrse	obscure, spine retrorse or absent	variable, introrse, retrorse, or obsolete	not known
Pollen	2% approximately abnormal	4% approximately abnormal	6–12% abnormal	not known

rey pine hybridizes naturally with the coastal form of knobcone pine near Swanton, Santa Cruz County, California.

The findings regarding this hybrid illustrate a considerable and growing body of experimental evidence that challenges the accepted taxonomic placement of the recognized species of the genus *Pinus*. It is suspected that the commonly recognized species may, in many instances, conform closely to the subspecies of present-day thinking. One ancillary value of the pine breeding work being done at the Institute of Forest Genetics is the accumulation of experimental evidence that may contribute to a revision of the genus.

To record this hybrid form it is herewith described. The name proposed was chosen to show the derivation of the hybrid and to avoid the confusion that might follow the use of an orthodox name that gives no clue to the origin of the form described.

Pinus attenuradiata hybr. nov.

Arbor hybrida (*Pinus attenuata* × *P. radiata*), altitudo mediocris, recta, pyramidata vel sub-rotunda, *Pinus radiata* similis; ramis numerosis, verticillatis, adscensis, apicibus diffusis; ramulis asperatis, squamis superioribus hyalinis; corte asperato, crasso, obscuro; gemmis terminalibus ovatis, acutis, 5–8 mm. longis, fuscis vel sub-rufis; foliis ternis, raro binis aut quaternis, circa 10 cm. longis, tenuibus, obscuro-viridibus; vaginis 10–15 mm. longis, adpressis, persistentibus, membranaceis, squamis pallidis aut sub-rufis, marginibus albidis, fimbriatis; canalibus resiniferis, medianis; iulis staminiferis ovato-cylindratis, 10 mm. longis; conis inaequalibus, ovatis, 2–5 verticillatis, sub-sessilibus, 8–15 cm. longis, 4–8 cm. crassis, squamis obscuro-fuscis, apophysis pyramidatis, tumidis; umbonibus planis aut elatis, spinis retrorsis, introrsis aut obsoletis; seminibus obovatis, truncatis, rugosis, 5 mm. longis, 3 mm. latis, 1.5 mm. crassis, testis coriaceis, nigris; alis oblongis, obliquis, obtusis.

Type. Eddy Arboretum, Placerville, Eldorado County, California, August 21, 1945, *Stockwell* and *Kimbrough 2012* (Herbarium of the University of California no. 694111; isotype, Dudley Herbarium, Stanford University, California).

Institute of Forest Genetics, Placerville, California,
a branch of the California Forest and Range Experiment Station,
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United States Department of Agriculture,
in cooperation with the University of California at Berkeley.

A NEW ALPINE GLYCERIA FROM CALIFORNIA

Alan A. Beetle

The number of grass species confined to elevations of 9000 feet or higher in the Sierra Nevada of California is remarkably few. As reported to date they appear to be comprised of a pair of species each for *Poa* and *Agrostis* as follows: *Poa rupicola, P. Suksdorfii, Agrostis humilis,* and *A. Rossae.* Here, also, *Alopecurus geniculatus, A. aequalis* and *Koeleria cristata* occur as a disrupted and isolated part of their distribution for they are known also from northern and coastal California. Study has failed to reveal specific differences in the high montane phases of these last three species. It is of unusual interest, then, to find in these California mountains a dwarf species of *Glyceria,* of the section *Hydropoa* Dum., associated on the margins of alpine lakes with the equally restricted *Scirpus Clementis* Jones.

Glyceria californica sp. nov. Perennis pusilla; culmi erecti, usque ad 2 dm. alti; laminae usque ad 5 mm. latae; paniculae viride aut purpurascentes, erectae, scabrae, 3–6 cm. longae; spiculae circa 3 mm. longae, cum 3 ad 5 floris; glumae obtusae, gluma prima 1.26 mm. longa, gluma secunda 1.75 mm. longa; lemmae inferiorae cum 7 nervis, scabrae; paleae subaequalae.

Dwarf perennial; culms not over 2 dm. tall; blades up to 5 mm. broad, frequently exceeding the panicle; panicle green or becoming purple, 3–6 cm. long, erect, the short branches ascending, strongly scabrous; spikelets ca. 3 mm. long, 3- to 5-flowered; glumes broadly obtuse, the first 1.25 mm. long, the second 1.75 mm. long; lower fertile lemmas 3 mm. long, prominently 7-nerved, scabrous on and between the nerves, the apices erose; palea subaequal.

Type. Farewell, Tulare County, California, altitude 10,000 to 11,000 feet, *C. A. Purpus 2057* (type, Herbarium of the University of California, no. 121966). Also known from Rae Lake, Fresno County, *Mrs. Joseph Clemens* in 1910 (Clokey Herbarium at the University of California, Berkeley).

Division of Agronomy,
University of California, Davis.

A LIST OF ALGAE CHIEFLY FROM THE ALPINE ZONE OF LONGS PEAK, COLORADO

Walter Kiener

Phytogeographic considerations make it important to call attention to the fact that Colorado has a range of elevation from 3350 feet above sea level (at the Arkansas River, Prowers County) to 14,420 feet at Mount Elbert. The approximate mean elevation for the entire state, as determined by the United States Geological Survey, is 6800 feet, which is higher than the average elevation of any other of the United States of America.

This wide range of elevation implies a wide range of climatic conditions to which the vegetation is adapted and results in the presence of a great variety of floral elements. Climatic conditions and characteristics of the flora in the alpine zone on Longs Peak are similar in many ways to those prevailing above the Arctic Circle. Not enough is known at the present time about the distribution of the algae in the alpine zone of the mountains of the United States to draw conclusions regarding the characteristic distribution patterns of the ninety-two entities here enumerated.

The data and the specimens here reported came chiefly from the alpine zone on Longs Peak, and were made as a part of a detailed survey of the vegetation of the alpine zone on that mountain. A few other collections from the lower life zones of Longs Peak and vicinity, as well as from other areas are listed here for the phytogeographic record. The collection numbers are those of the author. A given number may appear under several species because the collection contained an inseparable mixture. On the herbarium label the most abundant species is listed first, and the mixed specimen is filed under that species name.

Longs Peak is located at about latitude 40 degrees north. The alpine zone reaches from approximately 11,000 feet to 14,255 feet, the summit of Longs Peak. There is much overlapping of habitats between the alpine zone and the subalpine zone. Some alpine habitats may be as low as 11,000 feet, whereas, subalpine habitats under favorable conditions may be found up to nearly 12,000 feet. A habitat is here considered alpine or subalpine. respectively, on the basis of the kind of vegetation it supports. The county line between Larimer and Boulder counties crosses Longs Peak almost on its summit. Boulder Field is a shallow basin on the north flank of Longs Peak, and Chasm Lake in Chasm Gorge is on the east flank.

The writer is indebted to Mildred Hallberg Jones for many identifications in the earlier stages of the work. For the determinations of the diatoms, credit is due Dr. Ruth Patrick of the Philadelphia Academy of Sciences. But the identifications of nearly all specimens were made by Dr. Francis Drouet of the Chicago Natural History Museum, where the specimens are now on file in the cryptogamic herbarium. Without his help, always courteous and efficient, this list could not have been completed.

CHROOCOCCACEAE

CHROOCOCCUS TURGIDUS (Kütz.) Näg. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet. September 16, 1933, *171*. Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; over mosses on soil, July 9, 1941, *10393*.

GLOEOCAPSA VIOLACEA Kütz. Boulder County: Middle St. Vrain Valley, 7900 feet; montane; with other algae forming a purple-reddish crust on north-facing, intermittently wet, siliceous cliffs, October 11, 1937, *6245*.

GLOEOCAPSA GRANOSA (Berk.) Kütz. Larimer County: north slope of Mount Lady Washington, 12,000 feet; alpine; among squamulose lichens of snowpatch vegetation, July 31, 1936, *4434;* Boulder Field, 12,700 feet; alpine; on thallus of the lichen *Solorina crocea* in snowpatch vegetation, September 5, 1935, *7640*. Boulder County: alpine shore of Chasm Lake, 11,900 feet; alpine; among hepatics and squamulose lichens, July 25, 1938, *6410*.

GLOEOCAPSA MAGMA (Breb.) Kütz. Larimer County: near Chasm Lake, 11,700 feet; alpine; with other algae forming a blackish crust on wet, siliceous cliffs near Chasm Lake, October 7, 1937, *5682*. Boulder County: Middle St. Vrain Valley, 7900 feet; montane; with other algae forming a reddish crust on north-facing, intermittently wet, siliceous cliffs, October 11, 1937, *6245*. Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; on soil over mosses and pebbles, July 9, 1941, *10392, 10393, 10394*.

APHANOCAPSA RIVULARIS (Carm.) Rabh. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; with diatoms in shallow streamlet, September 8, 1933, *156;* Boulder Field, 12,700 feet; alpine; on thallus of *Solorina crocea* in snowpatch vegetation, September 5, 1935, *7644*. Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; over mosses on soil, July 9, 1941, *10393a*.

ANACYSTIS MARGINATA Menegh. Boulder County: Peaceful Valley, 9500 feet; subalpine; with other algae in shallow pool in spruce-fir forest, August 5, 1934, *1268;* summit of Longs Peak, 14,250 feet; alpine; growing over moss on intermittently wet rocks, September 14, 1936, *4768;* near Sandbeach Lake, 10,350 feet; subalpine; over lichen on wet ground of spruce-fir forest, September 12, 1937, *5597*.

ANACYSTIS PENIOCYSTIS (Kütz.) Dr. and Daily. Boulder County: Peaceful Valley, 9500 feet; subalpine; with other algae in shallow pool in spruce-fir forest, August 5, 1934, *1268;* near Chasm Lake, 11,800 feet; alpine; on intermittently wet, siliceous cliffs, September 18, 1934, *1277*.

ANACYSTIS RUPESTRIS (Lyngb.) Dr. and Daily. Park County: Hoosier Pass, 11,000 feet; subalpine; growing over moss on wet ground, September 1, 1938, *6705a*. Larimer County: Lily Lake, 9000 feet; montane; shallow water of shore, September 22, 1942, *13175*.

SYNECHOCOCCUS AERUGINOSUS Nag. Custer County: South Colony Creek, 11,500 feet; subalpine; growing over moss on rock ledge, July 9, 1941, *10393a*.

CHAMAESIPHONACEAE

CHAMAESIPHON INCRUSTANS Grun. Boulder and Larimer counties: alpine; apparently fairly common on filaments of various algae in streamlets and on wet cliffs at altitudes from 11,000 to 13,800 feet on Longs Peak. Tentative determinations were made, but no herbarium specimens prepared. The species was found to grow in one instance also on moss protonema and in another on fragments of submerged dead moss leaves.

Chamaesiphon polonicus (Rostaf.) Hansg. Boulder County: Chasm Gorge, 12,000 feet; alpine; on wet cliffs with lichen, September 21, 1936, *4187a*.

Chamaesiphon Rostafinskii Hansg. Larimer County: Alpine Brook at base of Longs Peak, 8900 feet; montane; shallow, running water, September 22, 1942, *13126*.

Oscillatoriaceae

Oscillatoria amphibia Gom. Larimer County: Boulder Field, 12,500 feet; alpine; with other algae in shallow streamlet, August 22, 1933, *154, 155, 156;* east slope at timberline on Longs Peak, 11,200 feet; subalpine; in shallow streamlets supplied by snow water, September 20, 1933, *178;* Granite Pass on Longs Peak, 11,900 feet; alpine; with other algae in shallow streamlet, September 20, 1932, *1428*.

Oscillatoria limosa Gom. Larimer County: Boulder Field, 12,500 feet; alpine; in shallow streamlet, August 22, 1933, *156*.

Oscillatoria proboscidea Gom. Larimer County: Boulder Field, 12,500 feet; alpine; in shallow streamlet, September 16, 1933, *157*.

Phormidium ambiguum Gom. Boulder County: north face of Longs Peak, 13,800 feet; alpine; among wet, siliceous rocks, September 10, 1937, *5570*.

Phormidium autumnale Gom. Boulder County: east face of Longs Peak, 12,500 feet; alpine; over wet mosses, August 9, 1936, *3860;* Chasm Gorge, 12,000 feet; alpine; with lichens on wet rocks, September 21, 1936, *4197*.

Phormidium subfuscum Gom. Boulder County: west face of Longs Peak, 13,300 feet; alpine; with lichens on wet, siliceous rocks, September 20, 1935, *3408a*.

Phormidium subfuscum var. Joannianum Gom. Boulder County: Mount Alice, 11,700 feet; alpine; with *Hydrurus foetidus* in cold spring rivulet, August 23, 1938, *6453*.

Phormidium uncinatum Gom. Larimer County: Alpine Brook at base of Longs Peak, 8900 feet; montane; reddish film in shallow running water, September 22, 1942, *13127*.

Lyngbya Diguetii Gom. Larimer County: Longs Peak, 9600 feet; subalpine; in rapids of Alpine Brook, September 11, 1935, *3361a*.

Lyngbya versicolor Gom. Boulder County: north face of Longs Peak, 14,000 feet; alpine; over mosses on wet ledge (cultured in laboratory), July 25, 1933, *167b*.

SYMPLOCA MUSCORUM (Ag.) Gom. Larimer County: east slope of Longs Peak, 11,100 feet; subalpine; over mosses among willows, August 15, 1934, *1603a;* among mosses and grasses, August 15, 1934, *1606;* on rotting wood on soil, September 16, 1934, *1753.* Park County: south side of Hoosier Pass, 11,100 feet; subalpine; over moss on wet ground, September 1, 1938, *6710.* Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; on soil among *Riccia* and *Selaginella, 10210;* on soil among mosses, July 8, 1941, *10262.*

MICROCOLEUS LACUSTRIS Gom. Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; soil among mosses, August 8, 1941, *10275.*

MICROCOLEUS VAGINATUS Gom. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; over mosses on ground, September 16, 1934, *1753.* Boulder County: Keyhole on Longs Peak, 13,200 feet; alpine; damp walls inside of primitive stone shelter, September 20, 1935, *3404.* Custer County: South Colony Basin at base of Humboldt Peak, 11,700 and 12,000 feet; subalpine; soil among bryophytes and lichens, July 8, 1941, *10207, 10262, 10275.*

SCHIZOTHRIX HEUFLERI Gom. Larimer County: near Chasm Lake, 11,700 feet; alpine; with other algae forming a blackish, shiny crust of considerable extent on wet, siliceous cliffs, October 7, 1937, *5682.* Teton County, Wyoming: on rocks at the subalpine shore of Jenny Lake, 6775 feet, September 8, 1936, *6065.*

SCHIZOTHRIX LACUSTRIS Gom. Larimer County: Alpine Brook on Longs Peak, 9600 feet; subalpine; on rocks in rapids, September 18, 1935, *3361b.*

SCHIZOTHRIX MUELLERI Gom. Larimer County: east slope on Longs Peak, at timberline, 11,100 feet; subalpine; among grasses and mosses, August 15, September 16, 1934, *1603, 1606, 1611.*

SCHIZOTHRIX PURCELLII W. R. Tayl. Larimer County: Boulder Field, 12,570 feet; alpine; soil among mosses in *Elyna Bellardi* community, September 12, 1935, *3253a.* Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; on ground over mosses, July 21, 1939, *6956.* Clear Creek County: Berthoud Pass, 10,500 feet; subalpine; among mosses, July 10, 1942, *W. L. Tolstead 10181a.*

SCHIZOTHRIX TINCTORIA Gom. Larimer County: Alpine Brook on Longs Peak, 9600 feet; subalpine; on rocks in rapids, September 18, 1935, *3361.*

SCHIZOTHRIX FRAGILIS Gom. Larimer County: Boulder Field, 12,700 feet; alpine; on thallus of the lichen *Solorina crocea* in snowpatch vegetation, September 5, 1935, *7642.*

PLECTONEMA NOSTOCORUM Gom. Larimer County: near Chasm Lake, 11,800 feet; subalpine; on intermittently wet, siliceous cliff, September 18, 1934, *1277;* Alpine Brook on Longs Peak, 9600 feet; subalpine; on rocks in rapids, September 18, 1935, *3361;*

Lily Lake, 9000 feet; montane; shallow water of shore, September 22, 1942, *13175*.

PLECTONEMA PURPUREUM Gom. Larimer County: east slope at timberline on Longs Peak, 11,100 feet; subalpine; inside of old bottle on soil under willows, September 15, 1933, *168*.

NOSTOCACEAE

NOSTOC COMMUNE B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; shallow streamlet, August 22, 1933, *142*, *146*. Boulder County: east face of Longs Peak, 13,800 feet; alpine; over mosses on wet, siliceous rock-ledges, August 16, 1934, *1286*. Park County: Hoosier Pass, 11,000 feet; subalpine; on wet ground over mosses, September 1, 1938, *6709*. Saguache County: Kit Carson Peak, 13,000 feet; alpine; in shallow cold-water pool, August 27, 1938, *6511*. Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; soil among bryophytes and lichens, July 8, 1941, *10262*.

NOSTOC cf. MUSCORUM B. and F. Microscopic study of mosses and lichens collected on Longs Peak at elevations ranging from 8000 to 13,700 feet showed this species to be present in eight collections. It was identified tentatively according to descriptions in the literature.

NOSTOC PARMELIOIDES B. and F. Larimer County: Alpine Brook at base of Longs Peak, 8900 feet; montane; rocks in swift water, September 22, 1942, *13132*; Roaring River below Lawn Lake, 10,500 feet; subalpine; rocks in swift water, September 22, 1942, *13206*.

CYLINDROSPERMUM MAJUS B. and F. Larimer County: base of Longs Peak, 9000 feet; montane; on soil among bryophytes and grasses, June 29, 1931, *10201a*.

SCYTONEMATACEAE

SCYTONEMA HOFMANNII B. and F. Boulder County: Long Lake, 10,400 feet; subalpine; soil among grasses and mosses, August 15, 1938, *6935*.

SCYTONEMA FIGURATUM B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, August 22, 1933, *140*, *144*, *147*; Granite Pass, 11,900 feet; alpine; shallow streamlet, September 17, 1934, *1276*. Boulder County: below Chasm Lake, 11,800 feet; subalpine; in shallow streamlet, August 1, 1934, *1285*.

SCYTONEMA OCELLATUM B. and F. Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; soil among bryophytes and lichens, July 8, 1941, *10264*.

SCYTONEMA TOLYPOTRICHOIDES B. and F. Larimer County: Boulder Field, 12,500 feet; alpine; in small streamlet with other algae, August 22, 1933, *141*; Granite Pass, 11,900 feet; alpine; shallow streamlet, September 17, 1934, *1275*.

Tolypothrix conglutinata B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; in shallow streamlet, August 22, September 17, 1933, *142, 146, 158.*

Tolypothrix penicillata B. and F. Larimer County: Alpine Brook at base of Longs Peak, 9100 feet; montane; on submerged, siliceous rocks, October 12, 1936, *5079.*

Tolypothrix tenuis B. and F. Larimer County: Granite Basin, 11,300 feet; subalpine; shallow streamlet, September 14, 1932, *126.*

Desmonema Wrangelii B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; in small streamlet with other algae, August 22, 1933, *142.* Boulder County: east face of Longs Peak, 13,800 feet; alpine; with other algae over mosses on wet, siliceous rock, August 16, 1934, *1288.*

Stigonemataceae

Stigonema mamillosum B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, August 22, September 16, 1933, *141, 159.*

This species is probably more abundant than these two records would indicate, but it seems impossible in the field to separate it from *Ephebe solida,* a lichen. Apparently it is only a matter of time and development when fungal hyphae infest the filamentous alga and transform it into the lichen. This lichen is fairly common in cold water and on wet ledges in the alpine zone.

Stigonema minutum B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, August 22, 1933, *140.* Boulder County: South St. Vrain Canyon, 7200 feet; montane; wet ground among mosses, September 29, 1938, *8804.*

Stigonema panniforme B. and F. Larimer County: Boulder Field, 12,570 feet; alpine; on ground on squamulose lichens, September 12, 1935, *3253a.*

Stigonema turfaceum B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, August 22, 1933, *139;* Granite Pass, 11,900 feet; subalpine; with other algae in shallow streamlet, September 17, 1934, *1276.*

Rivulariaceae

Calothrix parietina B. and F. Boulder County: creek at St. Malo, 8700 feet; montane; on rocks in creek, October 13, 1936, *2346.* Larimer County: near Chasm Lake, 11,700 feet; subalpine; with other algae forming a blackish crust on wet, siliceous cliffs, October 7, 1937, *5682.* Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; soil among bryophytes and lichens, July 8, 1941, *10275.*

Tribonemataceae

Tribonema bombycinum (Ag.) Derb. and Sol. Larimer and Boulder counties: 22 collections of this species were recorded during the months June, July, August and September at altitudes ranging from 10,400 to 14,000 feet. The plants were found in shallow streamlets, on wet, siliceous rock-cliffs, and over intermittently wet mosses on Longs Peak and vicinity.

Hydruraceae

Hydrurus foetidus (Vill.) Kirchn. Larimer County: Longs Peak, 10,800 feet; subalpine; in shallow streamlet among willows, September 16, 1935, *3384*. Boulder County: Mount Alice, 11,700 feet; alpine; with *Phormidium* in cold, spring rivulet, August 23, 1938, *6453*.

Coscinodiscaceae

Melosira ambigua (Grun.) Müll. Larimer County: east slope at timberline on Longs Peak, 11,100 feet; subalpine; in sediment in shallow pool among willows, September 20, 1933, *162, 163*.

Meridionaceae

Meridion circulare (Grev.) Ag. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*.

Diatomaceae

Odontidium anceps Ehr. Larimer County: recorded seven times in August and September, 1933, from the alpine zone on Longs Peak where it was found among other algae or in the sediment of shallow streamlets ranging in elevation from 11,100 at timberline to 13,800 feet on the east face of Longs Peak; Alpine Brook at base of Longs Peak, 9100 feet; montane; on sediment at edge of water, October 2, 1936, *4933*. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*.

Odontidium hiemale (Lyngb.) Kütz. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*.

Odontidium hiemale var. mesodon (Ehr.) Grun. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; in sediment in shallow pool, September 20, 1933, *163a;* Alpine Brook at base of Longs Peak, 9100 feet; montane; on sediment at edge of water, October 2, 1936, *4933*.

Fragilariaceae

Fragilaria Vaucheria (Kütz.) Boyl. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; September 1, 1934, *1293*.

EUNOTIACEAE

EUNOTIA MONODON Ehr. Larimer County: Boulder Field, 12,560 feet; alpine; shallow streamlet, August 22, 1933, September 12, 1935, *155, 3254*. Boulder County: east face of Longs Peak, 13,800 feet; alpine; with other algae over mosses on wet, siliceous rock, August 16, 1934, *1288*.

EUNOTIA PRAERUPTA Ehr. Boulder County: east face of Longs Peak, 13,800 feet; alpine; with other algae over mosses on wet, siliceous rock, August 16, 1934, *1288*. Larimer County: Boulder Field, 12,567 feet; alpine; with sterile *Zygnema* in shallow streamlet, September 12, 1935, *3254*.

EUNOTIA ROBUSTA Ralfs. Larimer County: Boulder Field, 12,567 feet; alpine; with sterile *Zygnema* in shallow streamlet, September 12, 1935, *3254*.

EUNOTIA TRIDENTULA var. **PERMINUTA** Grun. Larimer County: east slope of Longs Peak, at timberline, 11,100 feet; subalpine; in sediment in shallow pool among willows, September 20, 1933, *163a;* Granite Pass, 11,900 feet; alpine; with other algae in shallow streamlet, September 17, 1934, *1274*.

CERATONEIS ARCUS (Ehr.) Kütz. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*. Larimer County: Alpine Brook on Longs Peak, 9100 feet; montane; in creek, October 2, 1936, *4933*.

ACHNANTHACEAE

ACHNANTHES LANCEOLATA (Breb.) Grun. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; in shallow pool among willows, September 8, Sept. 20, 1933, *137, 163a*. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*.

ACHNANTHES MARGINULATA Grun. Larimer County: Boulder Field, 12,560 feet; alpine; in sediment of small streamlet, August 22, 1933, *148*.

NAVICULACEAE

PINNULARIA BOREALIS Ehr. Boulder County: east face of Longs Peak, 13,800 feet; alpine; with other algae over mosses on wet, siliceous rock, August 16, 1934, *1288*. Larimer County: Boulder Field, 12,567 feet; alpine; with sterile *Zygnema* in shallow streamlet, September 12, 1935, *3254*.

NITZSCHIACEAE

HANTZSCHIA AMPHIOXYS (Ehr.) Grun. Larimer County: east slope at timberline on Longs Peak, 11,100 feet; subalpine; from sediment of shallow pool among willows, September 8, 1933, *137*.

CHLAMYDOMONADACEAE

CHLAMYDOMONAS NIVALIS Wille. Larimer County: Jims Grove, Longs Peak, 11,200 feet; alpine; in surface of snow on snowpatch, September 14, 1933, *180;* Iceberg Lake, 12,000 feet; alpine; in surface of snow on snowpatch, September 21, 1935, *3362*. Custer County: Crestone Needle, 12,500 feet; alpine; in surface of snow, July 10, 1941, *10227*. This species is the cause of the phenomenon known as "red snow." It occurs sporadically during certain years and not in others, but when it does occur it usually is found on all the larger patches of snow. Numerous microscopic examinations were made of this snow organism in the living condition, but no motile cells were ever observed. Based on literature and illustrations, the writer identifies the organism as this world-wide species. Much more, however, needs to be known about the taxonomy and biology of this interesting plant.

CHLAMYDOMONAS YELLOWSTONENSIS Kol. Custer County: South Colony Basin at base of Humboldt Peak, 10,700 feet; subalpine; inside of surface of snow in residual snowdrifts in spruce forest, July 2, July 11, 1941, *10228*.

On parts of residual, fast-melting snowdrifts, whose surfaces were soiled by dirt and pine needles, a greenish tinge was observed. Upon scratching these tinged surfaces, a much more vivid green color appeared. A small glass jar was filled with "green snow" and taken along to camp at timberline where the jar was kept in a snowdrift for eight days. The snow inside the jar melted and the green algae settled on the bottom of the jar, but before eight days were ended, the algae had deteriorated. On July 11, upon leaving camp, another collection was made and preserved in formalin. These plants seem to agree with the description and illustrations as recently published by Erzsebet Kol (Am. Jour. Bot. 28: 185–190. 1941). There were, however, no motile cells observed. On the whole the cells averaged slightly larger in size in this material. The snow drifts were similar to those figured by Kol and also were from the spruce-fir life zone.

PALMELLACEAE

GLOEOCYSTIS VESICULOSA Näg. Boulder County: east face of Longs Peak, 12,500 feet; alpine; growing on lichen squamules on siliceous rock-ledges, August 9, 1936, *3866*.

ASTEROCOCCUS SUPERBUS (Cienk.) Scherff. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in shallow streamlet, September 16, 1933, *173*.

TETRASPORACEAE

TETRASPORA GELATINOSA (Vauch.) Desv. Boulder County: near Sandbeach Lake, 10,400 feet; subalpine; in small brook, September 1, 1934, *1273*.

COCCOMYXACEAE

OUROCOCCUS BICAUDATUS Grobety. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing with *Schizogonium* on wet, siliceous rock-ledges, July 25, 1933, *167*.

ULOTRICHACEAE

ULOTHRIX AEQUALIS Kütz. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in shallow streamlet, September 16, 1933, *160*.

ULOTHRIX TENERRIMA Kütz. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in shallow streamlet, August 22, 1933, *153*.

ULOTHRIX ZONATA (W. and M.) Kütz. Larimer County: Big Thomson Canyon, west of Loveland, 6500 feet; montane; floating in still water, September 26, 1942, *13274*.

STICHOCOCCUS BACILLARIS Näg. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing with *Schizogonium* on wet, siliceous rock-ledges, July 25, 1933, *167*.

STICHOCOCCUS SUBTILIS (Kütz.) Klerck. Larimer County: east slope at timberline on Longs Peak, 11,100 feet; subalpine; inside of old bottle on soil under willows, September 16, 1933, *168;* between siliceous rocks in snow water, September 20, 1933, *178*. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing on wet ledges, July 25, 1933, *167a, 167b*.

MICROSPORACEAE

MICROSPORA WILLEANA Lagerh. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; between siliceous rocks in snow water, September 20, 1933, *165*. Boulder County: Sandbeach Lake, 10,400 feet; subalpine; floating in shaded streamlet in spruce forest, September 1, 1934, *1291;* east face of Longs Peak, 13,700 feet; alpine; over wet mosses on siliceous rock-ledges, August 21, 1936, *4005*.

MICROSPORA AMOENA (Kütz.) Rabh. Larimer County: Alpine Brook, at base of Longs Peak, 8900 feet; montane; shallow, running water, September 22, 1942, *13126*.

CHAETOPHORACEAE

DRAPARNALDIA ACUTA (Ag.) Kütz. Boulder County: Sandbeach Lake, 10,350 feet; subalpine; shallow water of outlet, September 12, 1937, *5595*.

SCHIZOGONIACEAE

SCHIZOGONIUM spp.

PRASIOLA spp.

Many representatives of these two genera were found but they need further study.

CHLOROCOCCACEAE

CHLOROCOCCUM HUMICOLA (Näg.) Rabh. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing on wet rock-ledges, July 25, 1933, *167a*. Larimer County: Alpine Brook on Longs Peak, 9600 feet; subalpine; in rapids of creek, growing with *Prasiola,* September 18, 1935, *3361b*.

TREBOUXIA CLADONIAE (Chod.) G. M. Smith. Larimer County: Hewes Kirkwood at base of Longs Peak, 9100 feet; montane; granite rock on ground, from surface to 5 mm. deep under quartz crystals, October 14, 1936, *2444, 2445;* Cabin Rock on Twin Sisters Mountain, 9500 feet; subalpine; in surface layer of granitic rock, September 25, 1937, *6297;* east slope of Longs Peak at timberline, 11,100 feet; subalpine; over moss on ground, September 13, 1939, *9085;* east slope of Longs Peak, 9400 feet; subalpine; on soil and over mosses, September 23, 1942, *13187*. Boulder County: summit of Longs Peak, 14,250 feet; alpine; in surface layer of granitic rock, September 14, 1936, *4146*. Saguache County: Crestone Needle, 13,000 feet; alpine; soil and over *Selaginella,* July 8, 1941, *10300b*. Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; growing on lichen squamules, July 9, 1941, *10390*.

OOCYSTACEAE

CHLORELLA VULGARIS Beyer. Boulder County: west face of Longs Peak, 13,750 feet; alpine; growing with *Schizogonium* over wet, siliceous rocks, July 26, 1932, *1282*.

ANKISTRODESMUS FALCATUS (Corda) Ralfs. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing with *Schizogonium* on wet, siliceous rock-ledges, July 25, 1933, *167*.

VAUCHERIACEAE

VAUCHERIA SESSILIS (Vauch.) DC. Boulder County: Chasm Gorge, 12,200 feet; alpine; floating in cold streamlet, September 2, 1933, *134, 135*. Larimer County: Mount Lady Washington, 12,000 feet; alpine; bottom of dried-up streamlet, July 31, 1936, *4435;* Alpine Brook on Longs Peak, 9100 feet; montane; wet bank, August 10, 1935, *4948*.

ZYGNEMATACEAE

ZYGNEMA INSIGNE (Hass.) Kütz. Boulder County: Thunder Lake, 10,520 feet; subalpine; floating in shallow water at edge of Lake, August 27, 1931, *103*.

ZYGNEMA PECTINATUM var. ANOMALUM (Ralphs) Kirchner. Larimer County: Boulder Field, 12,560 feet; alpine; shallow streamlet, August 22, 1933, *155*.

ZYGOGONIUM ERICETORUM Kütz. Boulder County: Chasm Lake, 11,800 feet; subalpine; on wet, siliceous rock-cliff, September 18, 1934, *1290*.

MESOTAENIACEAE

CYLINDROCYSTIS BREBISSONII Menegh. Boulder County: near summit of Longs Peak, 14,000 feet; alpine; with *Schizogonium* over moss on wet, siliceous rock, July 22, 1932, *111;* east face of Longs Peak, 12,500 feet; alpine; over lichen squamules on wet, siliceous rock-ledges, August 9, 1936, *3866.*

DESMIDIACEAE

HYALOTHECA DISSILIENS (Smith) Breb. Boulder County: Sandbeach Lake, 10,350 feet; subalpine; shallow water of outlet, September 12, 1937, *5595.*

Desmids were generally not absent in the collections, particularly those made from the alpine zone, but were never abundant enough for separate determinations.

CHARACEAE

CHARA CONTRARIA A. Br. Larimer County: Marys Lake, 8000 feet; montane; on bottom in shallow water, August 3, 1930, *2278.* Determined by R. D. Wood.

Game, Forestation and Parks Commission, State of Nebraska,
and
Conservation and Survey Division, University of Nebraska, Lincoln.

REVIEW

Las Pináceas Mexicanas. By MAXIMINO MARTÍNEZ. Instituto de Biologia, Mexico, D. F., 1945. 345 pp. + 6 pp. index, 300 figs. (180 line drawings, 120 half tones), paper cover. Published also as: Tom. 16, Anales del Instituto de Biologia de la Universidad Nacional de Mexico. 1945.

This book is the result of years of meticulous work by Professor Martínez and is comprehensive in its taxonomic treatment of the genus *Pinus* in Mexico. It contains an extensive discussion of the genus, based on the pines of the New World, under such headings as seed, germination, trunk, bark, buds, branchlets, needles, leaf-sheaths, cones, and several other categories dealing with subheadings under some of the above.

Discussions of damaging insects, fungi, and other pests, of methods used to protect pine lumber, of turpentining methods, and of production and export of resins and other naval stores take up the remainder of the first fifty-two pages. Immediately following is a series of lists, each one giving the species, varieties and forms known to grow in one of the twenty-six states and territories covered. Jalisco and Mexico share honors with seventeen named entities credited to each.

On page fifty-six Professor Martínez begins his discussion of the classification of the pines of Mexico with a brief account of the history of the subject. The taxonomy of *Pinus* in Mexico began in 1832 when Zuccarini described *Pinus cembroides*. Additional species were soon described by authors in Europe and the United States. Gordon, for the first time, brought all available information together in his "Pinetum" in 1858. The next notable works covering the region were those of Shaw, "The Pines of Mexico" in 1909, and his monograph, "The Genus Pinus," published in 1914. Professor Martínez then decries Shaw's ultra conservatism by saying that Shaw followed an exaggerated tendency toward reducing species when he recognized only eighteen species and seventeen varieties of pines in Mexico. The author of this paper, after years of careful study, during which he examined more than 6,000 specimens and travelled extensively in the field, recognizes thirty-nine species, sixteen varieties, and ten formas. These he groups into nine sections. The ninth of the sections, the "Coulteri," contains only the single species, *P. Coulteri* Don. The largest section is the sixth, the "Montezumae," which consists of seven species, four varieties, and four formas. The other sections range between these two extremes in the number of entities included in each. Professor Martínez seems to have toyed with the idea of reducing *P. monophylla* and *P. quadrifolia* to varietal rank under *P. cembroides,* but retained them in specific rank. *P. edulis,* however, is reduced to a variety of *P. cembroides.* The reviewer once wrote to Professor Martínez that, ". . . perhaps *edulis* can be regarded best as a good variety or subspecies of *cembroides,* and that possibly all of that piñon pine group, *cembroides, edulis, monophylla,* and *quadrifolia* are just geographical expressions of one specific complex." This comment undoubtedly was the basis for the statement that "It is the opinion of the last author [Wiggins] that all of the piñons cited are geographical expressions of one specific complex" (p. 80). Obviously the qualifying "perhaps" was overlooked or misinterpreted, for the next sentence in my letter said that I had not studied *cembroides* nor *edulis* in the field, implying thereby that I placed no great weight upon that casual comment. In general, however, the quotations from communications and papers of other workers are well chosen and bolster the conclusions of the author.

A key to the species, which is mainly dichotomous but at places presents three or four parallel choices, is included. In this key use is made of cone shape and size, character of the umbo and apophysis, persistence or caducousness of scales, number, diameter and length of the needles, and a number of lesser characters in differentiating the species. In general the key appears quite workable, but it is doubtful if *P. radiata* and *P. attenuata* could be separated consistently by "Cone oblique, reflexed" (*P. attenuata*) and "Cone almost symmetrical, ovoid, spreading" (*P. radiata*). The key is so constructed that those species possessing the same number of needles in a fascicle fall into the same groups, even though the number of needles is not used as a key-character to the groups.

The description of each species is very complete and is written in a narrative style instead of in the manner followed by botanists in the United States and Europe, who generally omit verbs. The species are not numbered in the key nor in the text. Synonomy is not given for most of the combinations accepted. The reference to the original publication of a species is given in bold face type immediately following or just below the binomial and the author's name, these appearing in capitals but not in bold face. Distribution maps accompany some species while for others a general statement of range suffices, and in still other instances individual listing of localities may supplement or take the place of the general statement of range. Names of the collectors are rarely given, and one is not sure whether the other localities represent those spots where Professor Martínez personally observed the entity or only localities at which others collected or reported the particular pine. In some few cases the statement of range is based upon published comments of earlier writers and is sometimes open to question, e.g., the presence of *P. flexilis* in Baja California (p. 102).

A tabulation of novelties and new combinations reveals one new species, *Pinus lutea,* published by Sr. Ing. Cenobio E. Blanco (p. 233), seven new varieties, seven new formas, two new combinations and two new names. One of the new names is designated "new combination," but the varietal name applied is proposed to take the place of an earlier (and in the author's opinion, untenable) name. The new name, "var. *oaxacana*" under *P. pseudostrobus,* had not previously been used for the entity under consideration (p. 195). The ambiguity too often evident in the "International Rules of Botanical Nomenclature" may well account for the relegation of *P. pseudostrobus* var. *apulcensis* Shaw to synonomy under *P. pseudostrobus* var. *oaxacana* Martínez and the proposal of *P. pseudostrobus* var. *apulcensis* Martínez, not Shaw, for the material from Hidalgo. As I interpret the rules this course is not permissible and Shaw's combination must stand for the entity "*P. pseudostrobus* var. *apulcensis* (Lindley) Shaw," even though Shaw misidentified the material from Oaxaca as Lindley's *P. apulcensis.* (The last named pine came from Hidalgo.) Thus *P. pseudostrobus* var. *oaxacana* may miss being considered a new variety instead of a new combination only because it is not accompanied by a Latin diagnosis. Latin descriptions are provided for all the new varieties and for *P. lutea* Blanco, but are omitted following the denomination of the new formas.

In spite of the criticisms mentioned above, I consider the book a credit to its author and deserving of a place in the libraries and on the desks of all botanists who are interested in the pines of the Western Hemisphere. The detailed descriptions will prove of tremendous value to anyone needing to identify a pine from Mexico. The halftones of cones, bark, needles and general habit, mostly made from photographs taken by the author, help one greatly in visualizing the character of the trees about which Professor Martínez writes lucidly. Of high value, also, are the line drawings and distribution maps. Even though the number of resin canals in a given needle may vary between base and apex, the cross sections of needles are valuable in showing the general pattern of the tissues and cells in the needle of each species so illustrated. Personally, I am glad that he included them and congratulate Professor Martínez upon having secured the services of Sr. Manuel Ornelas C. to make the drawings of these sections and of needles, cones, and seeds.

The typography is good and the use of glazed paper did much to enhance the clearness and quality of reproduction of the figures. Typographical errors are commendably few. In my estimation, this book deserves praise and lots of use. May more such works come from the workers in botany in Mexico!—IRA L. WIGGINS, Stanford University, California.

NOTES AND NEWS

TYPE LOCALITIES AND MAN-MADE LAKES. It is reported that plans have been approved for the construction of several additional dams in California. Of these, the one of greatest concern to botanists is the proposed dam at Isabella in the southern Sierra Nevada. It is said that the high water level of the lake will follow the 2605-foot contour. This will form a lake flooding the Kern River Valley east to Weldon and north along the course of the main fork of the Kern River to the vicinity of Kernville. The Weldon arm of the lake will be approximately ten miles long and the Kernville arm, six miles long. Walker Pass and the Kern River Valley lie along one of the main migration routes into California and many plants were first collected and described from this area. In July of 1891, Coville and Funston, of the Death Valley Expedition, collected here. Later, the Brandegees and Alice Eastwood collected and subsequently described as new many of the plants they found in this region. Other botanists—principally Greene, Purpus, Heller, Marcus Jones—published a number of new species based upon Kern River Valley material. Much of this collecting was done during the spring and early summer months.

With the flooding of this vast area, all of these type localities will be lost to science, and some of the species may be lost with them. Intensive collecting in this area is urged before construction begins. In addition to yielding valuable topotype material, a thorough study of this area will give us a better basis for evaluating the vegetational changes that will take place after the establishment of the permanent lake.—ANNETTA CARTER, Department of Botany, University of California, Berkeley.